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Committed vs. uncommitted meat eaters: Understanding willingness to change protein consumption

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ABSTRACT

There is a growing trend of consumers in developed countries substituting alternative protein sources for meat and purchasing meat products with specific production-system related credence attributes. This study of Australian meat consumers identifies consumer segments with varying levels of willingness to make the following changes to their protein consumption: reduce meat consumption, follow a meat-free diet most of the time, avoid meat consumption altogether, and follow a strict plant-based diet (i.e., stop eating all animal-products). Segments are characterised, and predictors of segment membership are determined. Discrete Factor analysis, based on a nationally-representative sample of 287 Australian meat consumers surveyed in 2016, identified four unique segments. Findings show that 46% of consumers are not willing to make any changes to their meat/protein consumption ('Committed Meat Eaters'), 22% are willing to reduce meat consumption ('Willing Meat Reducers'), 15% are willing to stop meat consumption/consume plant-based protein foods only ('Prospective Veg*ns'), and 17% are undecided about future change ('Undecided Meat Eaters'). The key factor differentiating Committed Meat Eaters from other segments is the perception that food choices are inadequate in meat-free diets. Committed Meat Eaters are also less likely to believe livestock farming contributes to climate change, and to report a recent reduction in the consumption of at least one type of meat than are Willing Meat Reducers and Prospective Veg*ns. These findings are expected to be of interest to individuals and organisations who may play a role in meeting current and future consumer demand for meat and alternative protein products.

1. Introduction

Meat consumption patterns (including the volume and type of meat consumed) and purchase preferences, with regards to meat production-systems, are changing worldwide. Demand for meat is increasing at higher rates in developing countries with strong middle-class growth (OECD, 2016), and at lower rates in developed countries where there is a growing trend of consumers choosing meat-free or meat-reduced diets and substituting alternative protein sources for meat (Neff et al., 2018; OECD, 2016; Roy Morgan Research, 2016). In this paper, we focus on the changing meat/protein consumption (herein referred to as 'protein consumption') patterns in developed countries. This study aims to provide new and timely insight on consumer commitment to meat consumption in Australia, shedding light on how protein consumption may change in the near future, and the socio-demographic, psychographic and behavioural characteristics of consumers with a greater propensity for change. Study findings also provide a greater understanding of how meat purchase preferences are changing with respect to consumers seeking out products with specific production-system related credence attributes; and how these changes in purchase preferences are associated with propensity to change protein consumption patterns.

The production and consumption of meat has wide-ranging social, economic and environmental implications (Bouvard et al., 2015; Gerber et al., 2013; McEvoy, Temple, & Woodside, 2012; Meat & Livestock Australia, 2017b; Poore & Nemecek, 2018; Tilman & Clark, 2014). Accordingly, the insights generated by this research are expected to be of interest to a broad audience, including industries, organisations and individuals who may play a role in meeting current and future consumer demand for meat and alternative protein products.

From a nutritional and health stand-point, meat is a rich source of protein and minerals (such as iron and zinc) and is recommended as part of a healthy balanced diet (National Health and Medical Research Council, 2015). Some plant-based foods (e.g., legumes, nuts, seeds and products made from these foods such as tofu, tempeh, seitan, plant-based mince and burgers) and less-conventional foods, such as edible

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insects, provide similar nutrients to meat products and can, therefore, be consumed as meat substitutes (Akhtar & Isman, 2018; Craig & Mangels, 2009). Meat reduction and avoidance can, however, pose nutritional-risks if consumers are unable to make appropriate (nutritionally well-matched) dietary substitutions (Akhtar & Isman, 2018; Craig & Mangels, 2009). It is, therefore, important for health professionals and other trusted sources of nutrition information to be aware of both the likely shifts in consumption away from meat and possibly towards alternative protein sources, and the population subgroups more likely to make such changes. This understanding will allow health professionals to more effectively plan and provide support regarding appropriate dietary choices (i.e., protein alternatives).

Australia, known for its traditionally high per capita meat consumption, is an example of a country undergoing a transition in the total volume and type of meat consumed (Australian Bureau of Agricultural and Resource Economics and Sciences, 2017; OECD, 2018; Roy Morgan Research, 2016). The prevalence of vegetarianism ('full-time' meat avoidance) and flexitarianism ('part-time' vegetarianism) in the Australian population, has increased from 9% to 11% between 2012 and 2016 (Australian Bureau of Agricultural and Resource Economics and Sciences, 2017; Roy Morgan Research, 2016). Shifts in per capita consumption of different meat types have also seen chicken replace beef as the most commonly consumed meat type in Australia. Per capita consumption of chicken has exceeded that of beef since 2003–04 and in 2015–16, per capita beef consumption was also surpassed by pork (Australian Bureau of Agricultural and Resource Economics and Sciences, 2017). Further, the frequent media attention on animal welfare in Australia's livestock industries and debates on production standards (e.g., Free Range) over the last decade, have led to an increase in the labelling of various production-related credence attributes on meat products (e.g., Free Range, Certified Organic, Certified Humane, No Added Hormones, Antibiotic Free) (Australian Broadcasting Corporation, 2018, 2013; Australian Broadcasting Corporation Rural, 2011; Petrie, 2016).

From an environmental perspective, meat production (red meat in particular) can be resource intensive and is thought to contribute an estimated 15% of total greenhouse gas (GHG) emissions (Bradbear & Friel, 2011; Eshel, Shepon, Makov, & Milo, 2014; Gerber et al., 2013; Poore & Nemecek, 2018; Steinfeld, Gerber, Wassenaar, Castel, & de Haan, 2006; Yau, Thibodeau, & Not, 2018). Plant-based protein sources typically have a lower environmental impact than meat (including poultry, pork, beef and lamb) (Poore & Nemecek, 2018; Tilman & Clark, 2014), and edible insects have also been shown to be a more environmentally-friendly source of protein, relative to red meat (Akhtar & Isman, 2018). Dietary changes, such as population reductions in beef consumption (Natural Resources Defense Council, 2017), can play an important role in reducing GHGs (Eshel et al., 2014; Hallström, Röös, & Börjesson, 2014; Poore & Nemecek, 2018). Changes in meat production practices can also reduce GHG emissions, with a 30% reduction in GHG emissions believed possible in the livestock sector if current best practices were broadly implemented (Gerber et al., 2013). In Australia, the red meat industry is leading the way by setting a target to be carbon neutral by 2030 (Meat & Livestock Australia, 2017a). However, even with widespread producer adoption of the least emission intensive practices, environmental impact of the lowest-impact animal-products is expected to exceed the impact of plant-based meat substitutes (Poore & Nemecek, 2018). The willingness of current meat consumers to change their protein consumption patterns in the near future has not previously been investigated in Australia. Overall, this information can provide useful insight to policy makers on the feasibility of different dietary change/consumer-based climate change mitigation strategies (Poore & Nemecek, 2018; Wellesley, Froggatt, & Happer, 2015).

Research shows that consumers' purchase and consumption decisions related to meat and food products in general, are influenced by a complex and interrelated set of physical, physiological, psychological, social, economic and cultural factors (Font-i-Furnols & Guerrero, 2014; Grunert, 2006; Grunert, Bredahl, & Brunsø, 2004; Nestle et al., 1998). The literature further shows that ethical concerns related to farm animal welfare and environmental impact are commonly reported drivers of meat avoidance, while reductions in meat consumption are more commonly motivated by egoistic/private factors such as price and health concerns (Malek, Umberger, & Goddard, 2018; Neff et al., 2018). For consumers who may be concerned about animal welfare and/or environmental aspects of meat production, but not willing to stop consuming meat altogether, on-package communication of production-system related attributes of meat products provides an opportunity to express personal values and preferences (e.g., for more ethically produced meat) through purchase behaviour rather than eating behaviour. To our knowledge, no previous studies have examined associations between willingness to change protein consumption patterns and recent changes in meat purchase preferences, with respect to production-system related credence attributes.

The majority of the existing literature on consumer commitment to meat consumption and the motivations for and attitudes towards the reduction, avoidance and substitution of meat products is based on European and US studies (Apostolidis & McLeay, 2016; De Backer & Hudders, 2015; Graça, Calheiros, & Oliveira, 2015; Latvala et al., 2012; Neff et al., 2018; Piazza et al., 2015; Vainio, Niva, Jallinoja, & Latvala, 2016; Vanhonacker, Van Loo, Gellynck, & Verbeke, 2013). Relevant Australian data is limited to two studies (Bogueva, Marinova, & Raphaely, 2017; Malek et al., 2018), just one of which surveyed a nationally-representative sample (Malek et al., 2018); though the sole focus of that study was on reasons for recent reductions and increases in meat consumption. The present paper builds on those findings by providing new insight on the strength of meat preferences (herein referred to as 'commitment' to meat consumption) in Australia, and the propensity to make future changes to protein consumption among different consumer segments. This is achieved by identifying and characterising consumer segments with varying levels of willingness to make the following changes to their protein consumption in the coming weeks: reduce meat consumption, follow a meat-free diet most of the time, avoid meat consumption altogether, and follow a strict plant-based diet (i.e., stop eating all animal products). Socio-demographic, psychographic (food choice motivations, views regarding environmental issues, and perceptions of the convenience and adequacy of meat-free diets) and behavioural (consumption frequency of animal-based foods and meat-free meals; and recent reductions to meat consumption and changes to meat purchase preferences) factors are used to characterise consumer segments, and predictors of segment membership are also determined.

2. Methods

2.1. Study design and recruitment

An adult sample from the general Australian population was recruited by a reputable online panel provider (Pureprofile) in July 2016. All panel members who met the eligibility criteria (aged ≥18 years and living in Australia) had access to the web-based questionnaire (see supplementary material). A total of 506 respondents started the questionnaire, and 328 completed all questions (65% completion rate). After excluding meat-avoiders (n = 31) and respondents with invalid answers (n = 10), data from 287 meat-eating respondents remained for analysis. The sample included 151 females and 136 males, ranged in age from 18 to 81 years (Mean = 48.8, SD = 15.4), and was nationally-representative with respect to gender, age and location (metropolitan vs. other) (Australian Bureau of Statistics, 2017a). The University of Adelaide Human Research Ethics Committee provided ethical approval for the study (H-2016-156).

2.2. Data collection

The questionnaire used for data collection has been described previously by Malek et al. (2018). Briefly, the questionnaire assessed consumption frequency of animal products and meat-free main meals; recent changes made to meat consumption frequency and meat purchase behaviour, and reasons for changes; food choice motivations; perceptions regarding the convenience and adequacy of meat-free diets; willingness to change protein consumption; beliefs regarding environmental issues; and socio-demographic characteristics. Variables used in the present analysis are described below.

2.3. Willingness to change protein consumption

Participants were asked to indicate their willingness to do the following in the coming weeks: 'reduce meat consumption', 'follow a meat-free diet most of the time', 'avoid eating meat altogether' and 'follow a strict plant-based diet'. Willingness was rated on a 5-point scale from 1 = *Not at all willing to do this,* to 5 = *Very willing to do this*. For analysis, ratings of 4 and 5 were recoded as 'willing', and ratings of 1 and 2 as 'unwilling'. Where specified, 'unwilling' and 'neither unwilling nor willing' were collapsed into one category.

2.4. Consumption behaviour

Participants were asked to indicate how frequently they consume beef, chicken, pork, lamb, fish/seafood, dairy products and meat-free main meals during a typical month (e.g., 'During a typical month, how frequently do you eat a meat-free dish as your main meal (e.g., vegetable-based pasta dishes, vegetable stir-fries or risottos, vegetable frittatas or fritters, lentil curry etc.)?'). Responses were recoded into five categories for analysis: 'most days (5–7 days)', '2–4 days per week', '1 day per week', '1–3 times per month', 'less than once per month or never'. For each type of meat, respondents were also asked whether they have changed the frequency of their consumption within the previous 12 months, with response options: no change, reduced, increased, started eating, and stopped eating altogether.

For each meat type (beef, chicken, pork and lamb), participants were also asked to indicate whether they have changed their purchase behaviour such that they are now only consuming meat products with specific attributes. Attributes included as response options were 'specific cut(s)' and the following credence attributes related to meat production-system: Organic, Certified Humane, Free-Range, No Added Hormones, Antibiotic-Free, Raised/produced in Australia, Raised/produced by local livestock farmers.

2.5. Perceptions regarding meat-free diets

Convenience is a well-established food choice driver (Grunert, 2006; Renner, Sproesser, Strohbach, & Schupp, 2012; Steptoe, Pollard, & Wardle, 1995; Wansink, 2016) and has been consistently identified as a key driver of dinner meal choices in Australian consumer segments with diverse food and health mindsets (Australia Food News, 2013). Yet, little attempt has been made in the existing literature to examine the impact of convenience on willingness to change protein consumption patterns. In this study, perceived convenience of meat-free meal options was assessed using four statements adapted from the 'convenience' subscale of Steptoe et al.'s (1995) Food Choice Questionnaire (FCQ): 'Meat-free meal options are easy to prepare', 'Meat-free meal options are convenient', 'Meat-free meal options can be cooked very simply', and 'Meat-free meal options are easily available in shops and supermarkets'. The statements were rated on a 5-point Likert Scale where 1 = *strongly disagree* and 5 = *strongly agree*. A new variable (herein referred to as 'Meat-free meals are convenient') was created by calculating the mean score of the four items, with higher scores indicating greater perceived convenience of meat-free meal options.

Perceived adequacy of food choices in meat-free diets was assessed using the following three items drawn from (Graça et al., 2015): 'It's easy to have a meat-free diet', 'Nowadays there are good alternatives to meat consumption', and 'It's possible to have an adequate diet without eating meat'. These items were rated using the same 5-point Likert Scale as described above. A new variable (herein referred to as 'Adequate food choices in meat-free diets') was created by calculating the mean score of the three items, with higher scores on this variable indicating stronger agreement that food choices in meat-free diets are accessible and reasonable/practical. Mean scores of the two new variables were recoded into three categories indicating disagreement (scores ≤ 2.5), neither disagreement nor agreement (2.5–3.5, not inclusive), and agreement (≥ 3.5).

2.6. Food choice motivations

To assess the complex set of physiological, psychological, social and economic factors known to influence food consumption decisions, we used the extended version of the FCQ (Steptoe et al., 1995), which included three additional scales (Ecological Welfare, Political Values and Religion) developed by Lindeman & Väänänen (Lindeman & Väänänen, 2000); and selected scales (Need & Hunger, Sociability, Social Norms and Social Image) from The Eating Motivations Survey (TEMS) (Renner et al., 2012). In total, 16 food choice motivation variables were assessed. Items from the FCQ were preceded by the text, 'It is important to me that the food I eat on a typical day … ', and rated: 'not at all important', 'a little important', 'moderately important' or 'very important' (scored 1 to 4). TEMS items were preceded by the text, 'In terms of food, I eat what I eat … ', and rated on a 7-point Likert scale where 1 = 'Never', 2 = 'Rarely (less than 10% of the time)', 3 = 'Occasionally (about 30% of the time)', 4 = 'Sometimes (about 50% of the time)', 5 = 'Frequently (about 70% of the time)', 6 = 'Usually (about 90% of the time)' and 7 = 'Always'.

2.7. Environmental views

To assess views regarding the role of 'Farming the meat and dairy products that we eat and drink' in the human contribution to climate change, the following question was asked: 'How big a part, if any, do you think each of the following activities play in the human contribution to climate change? Response options were: 'a lot', a moderate amount', 'a little', 'nothing at all', and 'I don't know'. This question was adapted from (Wellesley et al., 2015). Response options were recoded into two new categories for analysis, with the first two response options coded as 1 and the others coded zero; this variable was named, 'Believe livestock farming contributes to climate change'.

2.8. Statistical analysis

Descriptive statistics were calculated. Chi-square tests were used to compare sociodemographic characteristics of consumers who were willing versus unwilling to make each of the four specified changes to their protein consumption; those who were 'neither willing nor unwilling' were included in the 'unwilling' category.

Exploratory factor analysis was performed to reduce the 16 food choice motivation variables into fewer variables for use in subsequent analysis. The factor analysis procedure and results are described in Malek et al. (2018). Briefly, three factors were extracted: 'Socially-oriented', reflecting food choices that are more strongly motivated by social factors such as social image, social norms and sociability; 'Production and origin focused', reflecting food choices that are more strongly motivated by a desire to minimise environmental impact and a respect for both animal and human rights; and 'Personal benefits', reflecting food choices that are more strongly motivated by personal benefits such as greater convenience, lower price and better sensory experience. Regression scores were calculated for each factor and new

variables were created, where 1 = scores in top-tertile, and 0 = all other scores.

To identify unique segments of meat consumers with different levels of willingness to change protein consumption patterns in the coming weeks, Discrete Factor (DFactor) analysis was performed in LatentGOLD (Version 5.1 Statistical Innovations, Inc., Belmont, MA, USA). DFactor analysis was used after latent class cluster analysis identified high bivariate residuals (> 1.0) between indicator variables and active covariates, indicating a violation of the local independence assumption. Unlike latent class cluster analysis, which assumes just one latent variable, DFactor analysis allows for these local dependencies (direct associations between indicators and covariates) through the addition of latent variables (discrete factors). Further, different to traditional factor analysis, DFactor analysis assumes that latent variables/DFactors are dichotomous or ordinal (i.e., each DFactor has two or more 'levels') rather than continuous and normally-distributed (Magidson & Vermunt, 2001; Vermunt & Magidson, 2005, pp. 41–62). Thus, each participant belongs to each DFactor level up to a probability and is assigned to the level with the highest probability.

The four indicator variables specified in the DFactor analysis were willingness to: reduce meat consumption, follow a meat-free diet most of the time, avoid eating meat altogether, and follow a strict plant-based diet; each of which had three response categories (unwilling, neither willing nor unwilling, and willing). Collapsing the original five-category indicator variables into three-categories was necessary to allow identification of a more parsimonious model that could be clearly interpreted. The following variables were initially included as covariates in the DFactor model to identify variables that could predict DFactor level membership: socio-demographics (gender, age, tertiary education, household income and location (metropolitan area vs. other)); food choice motivations; perceptions of environmental issues, and the convenience and adequacy of meat-free diets; consumption behaviour, including frequency of consuming different animal-based foods and meat-free main meals, and recent (last 12 months) reduction in the consumption of at least one type of meat (beef, chicken, pork, lamb). The unique combinations of DFactor levels form 'joint DFactor levels' (consumer segments). Post-hoc chi-square tests (with Bonferroni adjusted p-values) and ANOVA were used to examine associations between joint DFactor level/segment membership and participant characteristics (including variables that were not significant predictors of DFactor level membership, and recent changes to meat purchase preferences).

3. Results

3.1. Participant characteristics

The socio-demographic characteristics of the total sample are shown in Table 1, along with a comparison of characteristics of those willing versus unwilling to make the following consumption changes: reduce meat, stop eating meat, eat meat-free most of the time, and eat a strict plant-based diet (i.e., no animal products). The only statistically significant difference found related to gender, such that a higher share of females was willing to reduce meat consumption, $\chi 2$ (1, n = 287) = 3.873, p = 0.049, Phi = 0.12; and age, with meat-eaters aged < 35 years more willing to eat meat-free most of the time, $\chi 2$ (2, n = 287) = 6.755, p = 0.034, Cramer's V = 0.15.

3.2. Perceptions of meat-free meals/diets

Items in the 'Meat-free meals are convenient' scale had high internal consistency (Cronbach's α = 0.85). Mean score for the total sample was 3.26, with a standard deviation (SD) of 0.80. Overall, 45% of respondents had scores indicating agreement. Items in the 'Food choices in meat-free diets are adequate' scale had good internal consistency (Cronbach's α = 0.76). Mean score for the total sample was 3.06, with SD of 0.91. Overall, 32% of respondents had scores indicating agreement.

3.3. Discrete factor analysis– segmentation of meat consumers based on level of willingness to change protein consumption

Model fit was checked for up to five discrete factors (DFactors) using the Bayesian Information Criterion (BIC). Based on the minimum BIC value, the optimal solution was a 2DFactor model, with each of the two DFactors comprising two levels. The 2DFactor model had a standard R^2 of 0.98 (DFactor1) and 0.835 (DFactor2); entropy R^2 of 0.980 (DFactor1) and 0.811 (DFactor2); and classification error of 0.004 (DFactor1) and 0.054 (DFactor2). All four indicator variables discriminated well between the two levels of DFactor1 and DFactor2 (P < 0.001).

The DFactor loadings and communalities of the indicator variables are shown in Table 2. The communalities indicate that 81% of the variation in willingness to 'Avoid eating meat altogether' is explained by the DFactor model, with the model explaining slightly less variation in responses to the other items (58–77%). In total, the two factors explain 71% of the total variation in responses to the four items. While DFactor1 scores account for most of the variation in willingness to 'follow a meat free diet most of the time', 'avoid eating meat altogether' and 'follow a strict plant-based diet', most of the variation in willingness to 'reduce meat consumption' is accounted for by DFactor2 scores.

The retained covariates in the DFactor model (see Table 3) significantly influenced level assignment for DFactor1 and/or DFactor2, and reduced classification errors. Covariates that did not significantly influence level assignment for either DFactor were used for descriptive profiling of classes only rather than for prediction/classification of respondents into DFactor levels. The two exceptions were the variables, "Top tertile of 'Production and origin focused' food choice motivation factor regression scores" and "Top tertile of 'Personal benefits' food choice motivation factor regression scores"; these variables were not statistically significant predictors of DFactor level/class membership yet were retained as they were identified as potential confounding variables and inclusion reduced classification errors.

The 2DFactor model shows that the four specified changes to protein consumption patterns (indicator variables) represent two distinct mindsets (latent variables) around changes to personal protein consumption patterns. Different consumer characteristics (including food choice motivations, perceptions and meat consumption behaviour) predict how strongly each consumer is aligned with each mindset (DFactor) and help to classify respondents into one of the two levels of each DFactor. Table 3 shows the parameter estimates for the indicators and DFactor models, along with the marginal probabilities for the indicators and covariates for each DFactor level.

The results suggest that DFactor1 distinguishes between two groups of consumers. One group (Level 1, comprising 68% of the sample) comprises consumers who: are *not willing* to reduce their meat consumption to any extent (i.e., none of the four specified changes); are more likely to disagree (and less likely to agree) that food choices are adequate in meat-free diets; are less likely to be influenced by social factors and more likely to be influenced by personal benefits when making everyday food choices; consume beef more frequently (on average, 1–4 days per week); and are less likely to consume meat-free meals more than once per week. The other group ('Level 2', 32% of sample) comprises consumers who: are either *undecided* or *willing* to make the four specified changes to their meat consumption; are more likely to agree (and less likely to disagree) that food choices are adequate in meat-free diets; are more likely to be influenced by social factors and less likely to be influenced by personal benefits when making food choices; consume beef less frequently (on average, 1 day per week); and are more likely to consume meat-free meals more than once per week.

Table 1
Participant characteristics.

	General Australian population[a] (%)	Total study sample, n = 287 (%)	Reduce meat consumption (%)		Avoid meat consumption (%)		Meat-free most of the time (%)		Strict plant-based diet (%)	
			Willing (n = 79)	Not willing (n = 208)	Willing (n = 45)	Not willing (n = 242)	Willing (n = 44)	Not willing (n = 243)	Willing (n = 33)	Not willing (n = 254)
Female	51	53	62	49*	53	53	66	50	42	54
Age (years)										
< 35	28[b]	22	25	21	31	21	36*	20*	30	21
35-54	35	40	37	41	29	42	27	42	33	41
≥55	37	38	38	38	40	37	36	38	36	38
University degree	31[c]	32	37	31	36	32	30	33	39	32
Top income tertile for sample (≥$85,000)	50[d]	38	39	37	42	37	39	37	48	36
Metropolitan area	67	63	62	64	69	62	66	63	67	63

*P < 0.05 for comparison of 'willing' vs. 'not willing' participants for each specified dietary change (main column heading). Comparison of column proportions was not done across dietary changes.

[a] Data from Australian Bureau of Statistics, 2017a) unless otherwise specified.

[b] Values ar % of population aged ≥20 years (Australian Bureau of Statistics, 2017a). Lowest age category defined as: 20–34 years (Australian Bureau of Statistics, 2017a).

[c] Based on ata for Australians aged 20–64 years; (Australian Bureau of Statistics, 2017b).

[d] Household income per week at top of 50th percentile is $84,032 (Australian Bureau of Statistics, 2018).

Table 2
DFactor loadings and communalities of indicator variables*.

	DFactor1	DFactor2	R^2 (Communalities)
Reduce meat consumption	0.33	0.53	0.58
Follow a meat-free diet most of the time	0.68	0.31	0.77
Avoid eating meat altogether	0.79	0.26	0.81
Follow a strict plant-based diet	0.74	0.24	0.67

* Categories for indicator variables: unwilling, undecided (neither willing nor unwilling), willing.

In contrast, DFactor2 distinguishes between consumers who are unwilling to reduce their meat consumption (Level 1, 64% of sample) and those who are willing (Level 2, 36% of sample). Consumers who have a higher probability of belonging to Level 1 (unwilling group) are more likely to disagree (and less likely to agree) that food choices are adequate in meat-free diets; are less likely to have reduced their consumption of at least one type of meat in the previous 12 months; and are less likely to believe that livestock farming contributes to climate change. The opposite applies for consumers who are more likely to belong to Level 2 (the willing group).

The four possible unique combinations of DFactor1 and DFactor2 levels, form four 'joint DFactor levels' (herein referred to as 'classes'). The joint probabilities for the indicators and covariates for each class are shown in Table 4. The four classes named, 'Committed Meat Eaters (MEs)', 'Willing Meat Reducers (WMRs)', 'Undecided Meat Eaters (MEs)' and 'Prospective Veg*ns', are described under individual headings below. The term 'Veg*ns' refers to both vegetarians and vegans. Table 5 shows results of descriptive profiling based on socio-demographics, perceptions regarding the convenience of meat-free diets, and consumption frequency of different animal-based foods. Results of descriptive profiling based on recent changes to meat purchase patterns (i.e., preferred attributes of meat purchases) are shown in Table 6. Overall, no statistically significant socio-demographic differences were found between-segments; differences were found only for meat-free diet perceptions, dairy consumption frequency, and recent changes to meat purchase patterns.

4. 'Committed Meat Eaters'

The 'Committed MEs' class was the largest of the four classes and comprised 46% of the sample. Consumers in this class were unwilling to make any of the specified changes to their protein consumption.

4.1. Class membership predictors

Of all classes, Committed MEs were most likely to disagree (and least likely to agree) that food choices are adequate in meat-free diets (Table 4). Compared to WMRs and Prospective Veg*ns, Committed MEs were less likely to: be influenced by social factors when making everyday food choices; believe that livestock farming contributes to climate change; and report reducing consumption of at least one type of meat in the previous 12 months. Committed MEs were also less likely to be influenced by production and origin related factors when making everyday food choices, than WMRs; consumed beef more frequently, on average, than Undecided MEs (1–4 days per week vs. 1 day per week); and were less likely to consume meat-free meals more than once per week, when compared to Undecided MEs and Prospective Veg*ns.

4.2. Descriptive profiling

While not predictive of class membership, Committed MEs were more likely, than all other classes, to disagree that meat-free meal options are convenient; and were also less likely to agree than were WMRs and Prospective Veg*ns (Table 5).

Committed MEs were similar to Undecided ME with respect to recent changes to meat purchase patterns, with the only statistically significant between-class difference being that Undecided MEs were more likely to report that they purchase only Organic beef and pork (Table 6). In contrast, many differences were found between Committed MEs and both WMRs and Prospective Veg*ns. Compared to both WMRs and Prospective Veg*ns, Committed MEs were less likely to report purchasing only Certified Humane beef, chicken and pork; Pasture Raised beef; No Added Hormones chicken; Antibiotic Free chicken and pork; Australian raised/produced lamb; and locally raised/produced chicken and pork. Compared to WMRs, Committed MEs were less likely to report purchasing only Australian raised/produced beef, chicken and pork. Compared to Prospective Veg*ns, Committed MEs were less likely to report purchasing only specific cuts of chicken; Organic beef, chicken, pork and lamb; Free Range/Pasture Raised chicken and lamb; No Added Hormones pork; Antibiotic Free lamb; and locally raised/produced lamb.

Table 3
Parameter estimates for the 2DFactor model, and marginal probabilities for the indicators and covariates for each DFactor level.

	DFactor 1						DFactor 2					
	Parameter estimates				Marginal probabilities (%)		Parameter estimates				Marginal probabilities (%)	
	β	SE	z-value	p-value	Level 1 (68%)	Level 2 (32%)	β	SE	z-value	p-value	Level 1 (64%)	Level 2 (36%)
Models for Indicators												
Indicators												
Reduce meat consumption												
Unwilling	−4.34	0.66	−6.55	< 0.001	58	3	−5.36	1.21	−4.44	< 0.001	62	2
Neither willing nor unwilling	−0.02	0.39	−0.04		24	49	−1.10	0.66	−1.68		36	25
Willing	4.35	0.73	5.93		18	48	6.46	0.86	7.52		1	73
Follow a meat-free diet most of the time												
Unwilling	−6.52	0.87	−7.50	< 0.001	91	2	−5.09	0.72	−7.12	< 0.001	73	45
Neither willing nor unwilling	1.35	0.53	2.57		7	55	−2.13	0.47	−4.57		27	13
Willing	5.17	0.87	5.96		2	43	7.22	0.73	9.91		0	42
Avoid eating meat altogether												
Unwilling	−6.49	1.93	−3.36	< 0.001	99	4	−2.21	2.47	−0.89	< 0.001	74	3
Neither willing nor unwilling	1.07	0.54	1.99		1	56	−1.23	1.20	−1.03		25	3
Willing	5.41	2.01	2.69		0	40	3.44	1.42	2.42		1	1
Follow a strict plant-based diet												
Unwilling	−3.66	0.40	−9.14	< 0.001	96	8	−0.07	0.56	−0.13	< 0.001	72	61
Neither willing nor unwilling	2.46	0.52	4.71		2	59	−1.93	0.41	−4.74		27	10
Willing	1.20	0.57	2.12		2	32	2.00	0.65	3.08		2	29
Intercepts												
Reduce meat consumption												
Unwilling	3.50	0.57	6.16	< 0.001								
Neither willing nor unwilling	1.87	0.33	5.60									
Willing	−5.38	0.78	−6.90									
Follow a meat-free diet most of the time												
Unwilling	6.33	0.70	9.10	< 0.001								
Neither willing nor unwilling	1.94	0.47	4.10									
Willing	−8.28	0.85	−9.77									
Avoid eating meat altogether												
Unwilling	5.83	1.77	3.30	0.004								
Neither willing nor unwilling	0.81	0.56	1.44									
Willing	−6.64	2.02	−3.29									
Follow a strict plant-based diet												
Unwilling	2.87	0.39	7.42	< 0.001								
Neither willing nor unwilling	−0.60	0.47	−1.28									
Wiling	−2.26	0.69	−3.30									

	DFactor 1						DFactor 2					
	Parameter estimates				Marginal probabilities (%)		Parameter estimates				Marginal probabilities (%)	
	β	SE	z-value	p-value	Level 1 (68%)	Level 2 (32%)	β	SE	z-value	p-value	Level 1 (64%)	Level 2 (36%)
Model for DFactors												
Intercept												
Level1*	1.00	0.27	3.74	< 0.001			0.13	0.26	0.49	0.62		
Covariates												
Top tertile of 'Socially-oriented' food choice motivation factor regression scores	1.04	0.18	5.76	< 0.001	22	57	0.18	0.20	0.92	0.360	31	36
Top tertile of 'Production and origin focused' food choice motivation factor regression scores	0.15	0.18	0.84	0.400	32	35	0.43	0.23	1.85	0.065	25	47
Top tertile of 'Personal benefits' food choice motivation factor regression scores	−0.42	0.21	−2.00	0.045	36	28	−0.05	0.23	−0.22	0.820	30	40
Believe livestock farming plays role in human contribution to climate change	−0.13	0.17	−0.75	0.450	41	44	0.53	0.17	3.07	0.002	31	60
Perceived adequacy of food choices in meat-free diets												
Disagree	−1.67	0.41	−4.04	< 0.001	35	6	−0.95	0.30	−3.19	0.004	34	11
Neither disagree nor agree	0.48	0.26	1.81		42	45	0.23	0.23	1.01		42	44
Agree	1.19	0.28	4.23		23	49	0.72	0.25	2.88		24	46
Meat-free main meal more than once per week	0.39	0.17	2.30	0.021	21	48	0.02	0.20	0.11	0.910	27	35
Recent (last 12 months) reduction in consumption of at least one type of meat (beef, chicken, pork, lamb)	0.31	0.16	1.95	0.051	38	48	0.55	0.19	2.81	0.005	32	58
Beef consumption frequency	0.41	0.17	2.46	0.014	2.5	2.0	−0.06	0.17	−0.36	0.720	2.4	2.3

* Level 2 values = negative of level 1 values.

Table 4
Joint probabilities for the indicators and covariates for each segment (joint DFactor level), and results of z-tests comparing column proportions.

	Committed meat eaters (%)	Willing meat reducers (%)	Undecided meat eaters (%)	Prospective Veg*ns (%)	Total sample (n = 287) (%)
DFactor1 level	1	1	2	2	
DFactor2 level	1	2	1	2	
Class size	46	22	17	15	
Indicators					
Reduce meat consumption					
Unwilling	84[a]	0[b]	6[b]	0[b]	40
Neither willing nor unwilling	16[a]	43[b]	90[c]	0[d]	32
Willing	0[a]	57[b]	4[a]	100[c]	28
Follow a meat-free diet most of the time					
Unwilling	99[a]	73[b]	2[c]	0[c]	62
Neither willing nor unwilling	1[a]	19[b]	98[c]	5[a,b]	22
Willing	0[a]	8[b]	0[a,b]	95[c]	15
Avoid eating meat altogether					
Unwilling	99[a]	98[a]	6[b]	0[b]	69
Neither willing nor unwilling	1[a]	2[a]	90[b]	17[c]	19
Willing	0[a]	0[a]	4[a]	83[b]	13
Follow a strict plant-based diet					
Unwilling	96[a]	95[a]	6[b]	10[b]	68
Neither willing nor unwilling	3[a]	0[a]	90[b]	24[c]	21
Willing	1[a]	5[a]	4[a]	66[b]	12
Active covariates					
Top tertile of 'Socially-oriented' food choice motivation factor regression scores	20[a]	25[a]	60[b]	54[b]	33
Top tertile of 'Production and origin focused' food choice motivation factor regression scores	23[a]	51[b]	28[a,b]	44[a,b]	33
Top tertile of 'Personal benefits' food choice motivation factor regression scores	32[a]	44[a]	24[a]	32[a]	33
Believe livestock farming plays role in human contribution to climate change	30[a]	63[b]	30[a]	61[b]	42
Food choices in meat-free diets are adequate					
Disagree	45[a]	13[b]	8[b]	2[b]	25
Neither disagree nor agree	38[a]	49[a]	52[a]	37[a]	43
Agree	17[a]	38[b]	40[b]	61[b]	32
Meat-free main meal more than once per week	20[a]	24[a,b]	48[c]	49[b,c]	30
Recent (last 12 months) reduction in consumption of at least one type of meat (beef, chicken, pork, lamb)	30[a]	56[b,c]	34[a,c]	63[b]	41
Beef consumption frequency					
< Once/month or Never	3[a]	6[a,b]	14[b]	12[a,b]	7
1–3 times/month	11[a]	8[a]	18[a]	15[a]	12
1 day/wk	24[a]	32[a]	34[a]	22[a]	27
2–4 days/wk	56[a]	51[a,b]	30[b]	46[a,b]	49
5–7 days/wk	7[a]	3[a]	4[a]	5[a]	5
Mean (SD)[*, **]	2.5 (0.9)[b]	2.4 (0.9)[a,b]	1.9 (1.1)[b]	2.2 (1.1)[a,b]	2.3 (1.0)

In each row, values followed by the same letter are not statistically significantly different (at P = 0.05).
[*] Five categories, scored 0 = 4: 0 = < Once/month or Never, 1 = 1–3 times/month, 2 = 1 day/wk, 3 = 2–4 days/wk, 4 = 5–7 days/wk.
[**] ANOVA; F(3,283) = 5.17; Post-hoc Tamhane's T2: Mean difference (Committed MEs vs. Undecided MEs) = 0.6, 95% CI = 0.1–1.1, P = 0.005.

5. 'Willing Meat Reducers'

The WMRs class comprised 22% of the sample. Most consumers in this class were willing to reduce their meat consumption to some extent but were not willing to make any of the other specified changes (i.e., eat meat-free most of the time, avoid meat altogether or follow a strict plant-based diet).

5.1. Class membership predictors

Compared to Committed MEs, WMRs were more likely to: agree that food choices are adequate in meat-free diets; report reducing their consumption of at least one type of meat in the previous 12 months; and be influenced by production and origin related factors when making everyday food choices. WMRs were also less likely to be influenced by social factors when making everyday food choices, than were Undecided MEs and Prospective Veg*ns; less likely to consume meat-free meals more than once per week, compared to Undecided MEs; and were more likely to believe that farming meat contributes to climate change, than Committed MEs and Undecided MEs.

5.2. Descriptive profiling

WMRs consumed dairy products more frequently than did Undecided MEs (Table 5). Further, compared to Committed MEs, WMRs were more likely to report that they purchase only Certified Humane beef, chicken and pork; No Added Hormones chicken; Antibiotic Free chicken and pork; Australian raised/produced meat (all four types); and locally raised/produced chicken and pork (Table 6).

6. 'Undecided Meat Eaters'

'Undecided MEs' comprised 17% of the sample. Consumers in this class were neither willing nor unwilling to make any of the specified changes to their protein consumption.

6.1. Class membership predictors

Compared to both Committed MEs and WMRs, Undecided MEs were more likely to be influenced by social factors when making everyday food choices, and to consume meat-free meals more than once per

Table 5
Characteristics of participants assigned to segments (joint DFactor levels).

	Committed meat eaters (%)	Willing meat reducers (%)	Undecided meat eaters (%)	Prospective Veg*ns (%)	Total sample (n = 287) (%)	χ^2/F	p-value
Female	44	63	56	59	53	7.430*	0.059
Age (years)							
< 35	20	19	22	34	22	12.50*	0.052
35-54	40	37	56	27	40		
≥55	40	44	22	39	38		
University degree	29	40	34	29	32	2.342*	0.504
Metropolitan area	61	56	74	71	63	5.400*	0.145
Household income ≥ sample median	38	32	40	44	38	1.736*	0.629
Meat-free meals are convenient'							
Disagree	23[a]	3[b]	4[b]	0[b]	12	44.143*	0.000
Neutral	46[a,b]	40[a,b]	56[b]	27[a]	44		
Agree	32[a]	57[b,c]	40[a,c]	73[b]	45		
Average consumption frequency, mean(SD)[§]							
Chicken	2.7 (0.8)	2.9 (0.6)	2.6 (0.9)	2.7 (0.9)	2.7 (0.8)	2.366[2]	0.075
Pork	1.5 (1.0)	1.5 (1.1)	1.5 (1.3)	1.0 (1.2)	1.4 (1.1)	1.510[2]	0.216
Lamb	1.4 (1.1)	1.3 (1.1)	1.4 (1.1)	1.3 (1.2)	1.4 (1.1)	0.295[1]	0.829
Fish/Seafood	1.5 (1.1)	1.8 (1.1)	1.8 (1.0)	1.8 (1.3)	1.7 (1.1)	1.457[1]	0.226
Dairy	3.7 (0.7)[a,b]	3.8 (0.6)[a]	3.3 (1.0)[b]	3.4 (1.2)[a,b]	3.6 (0.8)	3.891[2,3]	0.011

In each row, values followed by the same letter are not statistically significantly different (at P = 0.05).
* Chi-squar test.
[1] ANOVA.
[2] Wlch's AOVA.
[§] Five cateories, scored 0 = 4: 0 = < Once/month or Never, 1 = 1–3 times/month, 2 = 1 day/wk, 3 = 2–4 days/wk, 4 = 5–7 days/wk.
[3] Dairy: Men difference = 0.5, 95% CI = 0.1–1.0, P = 0.015.

week. In contrast, Undecided MEs were less likely to: believe that livestock farming contributes to climate change, than WMRs and Prospective Veg*ns; and report reducing their consumption of at least one type of meat in the previous 12 months, compared to Prospective Veg*ns. As previously stated, Undecided MEs, consumed beef less frequently, on average, than Committed MEs.

6.2. Descriptive profiling

Undecided MEs were: more likely to report purchasing only Organic beef and pork than were Committed MEs; less likely to report purchasing only Australian raised/produced chicken than were WMRs; and were less likely to report purchasing only Certified Humane and No Added Hormones chicken than were Prospective Veg*ns (Table 6).

7. 'Prospective Veg*ns'

'Prospective Veg*ns' was the smallest class, comprising only 15% of the sample. Consumers in this class were willing to make all of the specified changes to their protein consumption.

7.1. Class membership predictors

Compared to both Committed MEs and Undecided MEs, Prospective Veg*ns were more likely to: believe that livestock farming contributes to climate change; and report reducing their consumption of at least one type of meat in the previous 12 months. Compared to Committed MEs, Prospective Veg*ns were more likely to agree that food choices are adequate in meat-free diets, and to consume meat-free meals more than once per week. Similar to Undecided MEs, Prospective Veg*ns were more likely to be influenced by social factors when making everyday food choices, than were the other classes.

7.2. Descriptive profiling

In addition, while not predictive of class membership, Prospective Veg*ns were more likely to agree that meat-free meal options are convenient than were Committed MEs and Undecided MEs (Table 5). Compared to Committed MEs, Prospective Veg*ns were more likely to report that they purchase only specific cuts of chicken; Organic beef, chicken, pork and lamb; Certified Humane beef, chicken and pork; Free Range/Pasture Raised beef, chicken and lamb; No Added Hormones and Antibiotic Free chicken, pork and lamb (Antibiotic Free only); Australian raised/produced lamb; and locally raised/produced chicken, pork and lamb (Table 6).

7.3. Recent changes to meat purchase patterns (i.e., preferred attributes of meat products)

The proportion of meat consumers (total sample) who, within the past 12 months, have started consuming only specific cuts of meat or meat products with specific credence attributes is also shown in Table 6. In most cases, changes in purchase preferences were more common for beef and chicken, than for pork or lamb.

Overall, the most commonly reported change to meat purchase behaviour for all meat types, apart from beef, was purchasing only 'Australian-produced' meat products (23–36% of consumers). For beef, the most commonly reported change to purchase behaviour was purchasing only 'Antibiotic Free' products, with two-in-five beef consumers reportedly making this change in the past 12 months; and fewer chicken, pork and lamb consumers reporting this change (13–23%). Similarly, about one-in-four beef and chicken consumers and one-in-six pork and lamb consumers recently started purchasing only 'No-Added Hormones' products.

The proportion of consumers who recently started purchasing only 'Free Range' products was highest for chicken meat (23% vs. 10–16% other meats); this was also the case for 'Certified Humane' products (20% chicken vs. 13–15% other meats). Lastly, approximately 10% of beef, chicken, pork and lamb consumers recently started purchasing only 'Organic' products.

8. Discussion

This is the first known study to identify and characterise unique

Table 6
Association between segment membership and recent changes in attributes of meat purchases.

	Committed meat eaters (%)	Willing meat reducers (%)	Undecided meat eaters (%)	Prospective Veg*ns (%)	Total sample (n = 287) (%)	χ^2	df	p-value	CV*
Beef									
A specific cut(s) [1]	8	13	4	17	9	5.900	3	0.117	–
Organic	4^{a}	$11^{a,b}$	16^{b}	20^{b}	10	12.210	3	0.007	0.21
Certified Humane[2]	7^{a}	25^{b}	$16^{a,b}$	22^{b}	15	14.263	3	0.003	0.22
Pasture-raised	8^{a}	22^{b}	$22^{a,b}$	24^{b}	16	11.198	3	0.011	0.20
No added hormones	18	33	18	37	24	7.210	3	0.066	–
Antibiotic-free	33	54	34	49	40	2.880	3	0.411	–
Raised/produced in Australia	17^{a}	25^{b}	$18^{a,b}$	$32^{a,b}$	21	7.860	3	0.049	0.17
Raised/produced by local livestock farmers	18	27	28	34	24	5.040	3	0.169	–
Chicken									
A specific cut(s) [1]	2^{a}	$10^{a,b}$	$4^{a,b}$	12^{b}	6	8.299	3	0.040	0.17
Organic	2^{a}	$10^{a,b}$	$10^{a,b}$	29^{b}	9	27.868	3	0.000	**0.31**
Certified Humane[2]	9^{a}	$30^{b,c}$	$18^{a,c}$	44^{b}	20	28.614	3	0.000	**0.32**
Free-range	15^{a}	$29^{a,b}$	$24^{a,b}$	39^{b}	23	11.840	3	0.008	0.20
No added hormones	17^{a}	$40^{b,c}$	$18^{a,c}$	46^{b}	26	21.561	3	0.000	0.27
Antibiotic-free	17^{a}	35^{b}	$16^{a,b,}$	37^{b}	23	13.682	3	0.003	0.22
Raised/produced in Australia	29^{a}	52^{b}	24^{a}	$49^{a,b}$	36	16.575	3	0.001	0.24
Raised/produced by local livestock farmers	13^{a}	29^{b}	$18^{a,b}$	37^{b}	21	14.051	3	0.003	0.22
Pork									
A specific cut(s) [1]	2	5	2	2	2	1.958	3	0.581	–
Organic	2^{a}	$11^{a,b}$	12^{b}	17^{b}	8	12.444	3	0.006	0.21
Certified Humane[2]	8^{a}	24^{b}	$10^{a,b}$	27^{b}	15	14.297	3	0.003	0.22
Free-range	9	14	8	20	11	4.471	3	0.215	–
No added hormones	10^{a}	$24^{a,b}$	$16^{a,b}$	27^{b}	16	10.051	3	0.018	0.19
Antibiotic-free	8^{a}	22^{b}	$14^{a,b}$	27^{b}	15	13.191	3	0.004	0.21
Raised/produced in Australia	17^{a}	35^{b}	$16^{a,b}$	$29^{a,b}$	23	9.880	3	0.020	0.19
Raised/produced by local livestock farmers	9^{a}	24^{b}	$12^{a,b}$	27^{b}	15	12.170	3	0.007	0.21
Lamb									
A specific cut(s) [1]	3	5	4	7	4	1.521	3	0.677	–
Organic	3^{a}	$6^{a,b}$	$4^{a,b}$	15^{b}	6	8.365	3	0.039	0.17
Certified Humane[2]	8	17	14	22	13	6.569	3	0.087	–
Pasture-raised	7^{a}	$10^{a,b}$	$12^{a,b}$	22^{b}	10	7.908	3	0.048	0.17
No added hormones	10	19	12	24	14	7.009	3	0.072	–
Antibiotic-free	9^{a}	$19^{a,b}$	$12^{a,b}$	27^{b}	14	9.657	3	0.022	0.18
Raised/produced in Australia	16^{a}	35^{b}	$22^{a,b}$	39^{b}	24	14.039	3	0.003	0.22
Raised/produced by local livestock farmers	9^{a}	$21^{a,b}$	$18^{a,b}$	37^{b}	17	17.708	3	0.001	0.25

In each row, values followed by the same letter are not statistically significantly different (at P = 0.05).
* CV = Cramers V effect size statistic.
[1] E.g. minc, steak, roast, breast, thigh, etc.
[2] Produced ccording to specific animal welfare standards.

segments of Australian meat consumers with differing levels of willingness to change their current protein consumption patterns. We also provide new insight on Australian consumers' perceptions of the convenience of meat-free meal options and adequacy of food choices in meat-free diets; and recent changes made to meat purchase patterns with respect to attributes of meat products.

8.1. Commitment to meat consumption

Consistent with recent Finnish research (Latvala et al., 2012), we showed that about one-half of Australian meat consumers are committed to meat consumption and are not willing to make any reductions to their personal meat consumption in the near future. The remaining meat consumers in our sample were either willing to reduce (22%) or avoid (15%) meat consumption or were undecided (17%). These latter consumers may, therefore, be more likely to shift towards dietary patterns lower in meat and higher in alternative protein sources, than the Committed MEs.

The key perceptions and behaviours differentiating the 'Committed' and 'Undecided' consumer segments from those who were willing to either reduce (WMRs) or cease meat consumption (Prospective Veg*ns), may be useful for informing the development of future strategies aimed at maintaining meat demand, encouraging meat consumption within healthy and environmentally sustainable levels and/or enabling consumers to make informed dietary decisions regarding meat substitutes/alternative protein sources. Specifically, our data reveal that consumers in the 'Committed' and 'Undecided' segments were less likely to believe that livestock farming plays a role in climate change. Further, the key factor differentiating the Committed MEs from all other segments was the perception that food choices are not adequate in meat-free diets. Compared to the WMRs and Prospective Veg*ns, the Committed MEs were also less likely to report a recent reduction in the consumption of at least one type of meat and were less likely to believe that meat-free meals are convenient. This suggests that along with the belief that meat production can negatively impact the environment, both personal experience with reducing meat consumption and beliefs about adequacy and convenience of food choices in meat-free diets, may play an important role in willingness to reduce personal meat consumption.

Supporting the suggestion that experience with a specific behaviour may influence future intentions regarding that behaviour, Jallinoja (2016) showed that consumers who intended to increase their bean consumption (as a source of plant-based protein) in the near future, were more likely to already include beans in their diet. The dynamic nature of attitude/perception formation and behavioural performance

is acknowledged in different theoretical frameworks (Fishbein & Ajzen, 2011; Shove, 2010). It is recognised that perceptions and attitudes associated with specific behaviours (in the present case, reduced meat consumption) do not always precede practice, but rather are formed during and shaped by practice, and continue to evolve over time as the behaviour is repeated; with practice influencing behavioural competence, opportunity and motivation (Michie, Hyder, Walia, & West, 2011). Thus, in the case of meat reduction, an initial experience with reducing meat consumption (which was more likely among the WMRs and Prospective Veg*ns), may lead to increased competence with reducing meat consumption and making appropriate dietary substitutions, which may lead to further opportunity and motivation for meat reduction/substitution.

Our finding that Committed MEs were less likely than other consumer segments to perceive food choices in meat-free diets as adequate and convenient, is also consistent with the literature (Macdiarmid, Douglas, & Campbell, 2016; Piazza et al., 2015; Verbeke & Viaene, 1999). Previous research shows that intention to reduce meat consumption in the near future is weaker among consumers who: consider 'taste' and 'ease of preparation' among their five most important meat attributes (Verbeke & Viaene, 1999); view meat consumption as an experience that is pleasurable and one that is driven by social pressure/expectations, and believe that meat is a staple in the human diet (Macdiarmid et al., 2016); do not perceive a need to reduce their meat consumption due to consuming only small quantities of meat or having already reduced their meat consumption (Macdiarmid et al., 2016); and have stronger perceptions regarding the niceness, necessity, normality and naturalness of meat consumption (Piazza et al., 2015). Overall, this suggests that sensory appeal, convenience, social norms, naturalness, and lack of perceived need to change personal meat consumption patterns are key factors contributing to commitment to meat consumption. Notably, these consumers are the target market for meat analogues such as plant-based 'meat' and lab-grown/cultured meat, which are designed to mimic the sensory experience of conventionally produced meat, whilst being produced in a more sustainable manner (Froggatt & Wellesley, 2019). Consumer acceptance is one of the key factors that will influence the future growth of the meat analogue industry, and requires further exploration in future studies.

Overall, we found low acknowledgment of the environmental impact of meat production in our Australian sample, with just two-in-five meat consumers believing that farming meat and dairy products contributes to climate change. This is consistent with findings from a larger Australian survey, which showed that just 32% of meat consumers are concerned about the environmental impact of meat production (Malek, Umberger, & Rolfe, 2017). Notably, the two consumer segments who were willing to either reduce (WMRs) or cease meat consumption (Prospective Veg*ns) were more likely than other segments to believe that livestock farming contributes to climate change. Findings from previous studies suggest that awareness of potential environmental impacts of meat production does not always influence personal meat consumption behaviour. For example, a recent UK study showed that even though meat consumers may be aware of the negative environmental consequences of meat consumption, some remain resistant to the idea of changing their personal meat consumption (Macdiarmid et al., 2016). Reasons underlying this resistance included: the beliefs that personal reductions in meat consumption would make no difference to environmental impact if others did not do the same, and that human activities other than food/meat production have a greater environmental impact; having already made a reduction to personal meat consumption; and performing other non-diet related pro-environmental behaviour in place of dietary changes (Macdiarmid et al., 2016). Similarly, a study of Flemish consumers found that even among those who believed their personal ecological footprint was large, not all considered their personal ecological footprint important in their own consumer choices; and, overall, livestock production was considered a less important human-related contributor to CO2-emissions and climate change, relative to industry, transport, energy use, consumption society and waste (Vanhonacker et al., 2013). Thus, while consumers may be aware of the link between meat production/consumption and environmental impact, for various reasons this awareness alone may not be enough to change their personal protein consumption patterns. Overall, this is consistent with our results showing that perceptions regarding adequacy of meat-free diets were a stronger predictor (Table 3), than the belief that livestock farming contributes to climate change.

Consistent with other consumer behaviour research investigating dietary determinants, we found psychosocial characteristics (e.g., motivations, beliefs and perceptions) to have a greater influence on segment membership than socio-demographic characteristics (Verbeke, 2005). We also found a significant difference in beef consumption frequency between some segments (Committed MEs vs. Undecided MEs). The only other comparable consumer segmentation study (Latvala et al., 2012) did not examine the influence of meat consumption frequency on segment membership, but rather used the data for descriptive profiling only. Overall, our results suggest that willingness to change protein consumption patterns is not always associated with current beef consumption frequency, though this requires validation in further studies.

8.2. Meat product attributes sought by meat consumers

Novel insight is also provided on links between willingness to change protein consumption patterns and recent changes to meat purchase behaviour. Notably, while Verbeke and Viaene (1999) showed an association between intention to reduce meat consumption and valuing hormone-free meat, ours is the first study to link meat reduction intentions with (self-reported) meat purchase behaviour. Specifically, our findings suggest that for meat consumers who are willing to reduce (WMRs) or cease meat consumption (Prospective Veg*ns), their continued purchase of specific types of meat may be contingent on access to meat products with specific production-system related credence attributes. In particular, WMRs and Prospective Veg*ns were more likely than Committed MEs to report recent changes such as only purchasing meat that is Organic, Certified Humane, Free-range/Pasture-raised, No-added hormones, Antibiotic-free, Australian produced and/or locally produced. This, together with the finding that the majority of WMRs and Prospective Veg*ns reported a recent reduction in their consumption of at least one type of meat, could suggest that when consumers reduce meat consumption, they become more selective with regards to meat product attributes. Alternatively, these findings could suggest that changes in meat consumption frequency occur simultaneously with, or come after, changes in purchase preferences. Another possible explanation is that willingness to reduce/cease meat consumption and/or recent reductions in meat consumption are a consequence of consumers' inability to identify meat products with key purchase-driving credence attributes at the point-of-purchase. If the latter is contributing to reductions in meat consumption and/or willingness to reduce/avoid meat consumption, it would be prudent for the meat industry to revisit their on-package communication strategies to ensure product labelling is clearly conveying the key credence attributes known to play a driving role in consumers' meat purchase decisions.

8.3. Strengths and limitations

A strength of this study includes the study sample, which matches the general Australian population with respect to gender, educational attainment, and area of residence (metropolitan vs. other) (Malek et al., 2018). In addition, we used a relatively novel statistical method (DFactor analysis) for the segmentation analysis, which, to our knowledge, has not previously been used in consumer food behaviour research; though has been used in health-related research (Romero-Ortuno, Walsh, Lawlor, & Kenny, 2010; Starkstein et al., 2011). The

main benefit of this method is that it can identify consumer segments based on more than one latent variable.

A limitation of the study is the lack of follow-up survey to determine whether willingness to change protein consumption was acted on. However, while an intention/willingness-behaviour gap is often reported in food and health behaviour research (Sheeran, 2002; Sniehotta, Presseau, & Araújo-Soares, 2014), research also shows that habitual behaviour (which meat consumption could be classed as) is often more reliably predicted by past-behaviour than behavioural intention. Accordingly, the greater likelihood of WMRs and Prospective Veg*ns reporting recent reductions in meat consumption, and the higher frequency of meat-free meal consumption among Prospective Veg*ns, adds credence to our segmentation findings as past meat reduction/meat-free meal consumption behaviour is consistent with reported willingness to change protein consumption patterns. Further, self-selection bias, whereby those more interested in meat consumption and food choices may have been more likely to participate in the study, may have influenced the findings, although this potential error is common to all survey research. Another consideration when interpreting the study findings is that frequency of meat consumption was examined but not usual portion size. However, food frequency questionnaires are commonly used in survey research and do not always include measures of portion size (Shim, Oh, & Kim, 2014).

9. Conclusion

This study reveals that almost one-half (46%) of Australian meat consumers are not willing to make any reductions to their meat consumption in the near future, and the remainder may be ready to shift (or have started considering a shift) towards a diet with less meat and/or more meat/protein alternatives. This shows that commitment to meat consumption varies among Australian meat consumers and suggests that changes in consumption patterns of meat and protein sources in general, may be a continuing trend, especially among meat consumers who believe food choices in meat-free diets are adequate and that livestock farming plays a role in climate change; and have already made recent reductions in the consumption of some meat types. These insights on the psychographic and behavioural predictors of segment membership can help to inform strategies aimed at meeting consumer demand for animal-based and/or plant-based protein products, encouraging healthy and environmentally sustainable levels of meat consumption and/or guiding consumers towards appropriate meat/protein alternatives. Importantly, while this research shows there exist segments of Australian consumers who are willing to change their protein consumption patterns, further research is required to determine the types of protein products that are likely to appeal and be accepted by these less-committed meat consumers.

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Appendix A. Supplementary data

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References

Akhtar, Y., & Isman, M. B. (2018). 10 - insects as an alternative protein source. In R. Y. Yada (Ed.). *Proteins in food processing* (pp. 263–288). (2nd ed.). Woodhead Publishing.

Apostolidis, C., & McLeay, F. (2016). Should we stop meating like this? Reducing meat consumption through substitution. *Food Policy, 65*, 74–89.

Australia Food News (2013). Convenience the key driver for Australia's food health choices. [Press release]. Retrieved from http://www.ausfoodnews.com.au/2013/11/18/convenience-the-key-driver-for-australia%E2%80%99s-food-health-choices.html.

Australian Broadcasting Corporation (2013). Beyond the label: The use and legislation of organic certification. [Press release]. Retrieved from http://www.abc.net.au/local/stories/2013/07/19/3806751.htm.

Australian Broadcasting Corporation (2018). *New free range egg laws have come into effect. Here's what you need to know.* [Press release]. Retrieved from https://www.abc.net.au/news/2018-04-26/new-free-range-egg-laws-come-into-effect/9696146.

Australian Broadcasting Corporation Rural (2011). The Indonesian live cattle export trade: Animal cruelty and economic uncertainty. [Press release]. Retrieved from http://www.abc.net.au/site-archive/rural/content/2011/s3234584.htm#The%20background.

Australian Bureau of Agricultural and Resource Economics and Sciences (2017). Agricultural commodities statistics 2017: Meat general. Table 12.1 Summary of Australian statistics for meat Canberra: Australian Government Retrieved from http://www.agriculture.gov.au/abares/publications/display?url=http://143.188.17.20/anrdl/DAFFService/display.php?fid=pb_agcstd9abcc0022017_IugZg.xml.

Australian Bureau of Statistics (2017a). *2016 census QuickStats: Australia.* Retrieved from Canberra: http://www.censusdata.abs.gov.au/census_services/getproduct/census/2016/quickstat/0.

Australian Bureau of Statistics (2017b). *Education and work, Australia.* ABS cat no. 6227.0 Retrieved from Canberra: http://www.abs.gov.au/ausstats/abs@.nsf/mf/6227.0.

Australian Bureau of Statistics (2018). *0 - household income and wealth, Australia, 2015-16.* 6523. from ABS http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/6523.02015-16?OpenDocument.

Bogueva, D., Marinova, D., & Raphaely, T. (2017). Reducing meat consumption: The case for social marketing. *Asia Pacific Journal of Marketing & Logistics, 29*(3), 477–500.

Bouvard, V., Loomis, D., Guyton, K. Z., Grosse, Y., El Ghissassi, F., Benbrahim-Tallaa, L., et al. (2015). Carcinogenicity of consumption of red and processed meat. *The Lancet Oncology, 16*(16), 1599–1600.

Bradbear, C., & Friel, S. (2011). *Food systems and environmental sustainability: A review of the Australian evidence.* Canberra, Australia: National Centre for Epidemiology and Population Health.

Craig, W. J., & Mangels, A. R. (2009). Position of the American dietetic association: Vegetarian diets. *Journal of the American Dietetic Association, 109*(7), 1266–1282.

De Backer, C. J. S., & Hudders, L. (2015). Meat morals: Relationship between meat consumption consumer attitudes towards human and animal welfare and moral behavior. *Meat Science, 99*(1), 68–74. https://doi.org/10.1016/j.meatsci.2014.08.011.

Eshel, G., Shepon, A., Makov, T., & Milo, R. (2014). Land, irrigation water, greenhouse gas, and reactive nitrogen burdens of meat, eggs, and dairy production in the United States. *Proceedings of the National Academy of Sciences, 111*(33), 11996–12001.

Fishbein, M., & Ajzen, I. (2011). *Predicting and changing behavior: The reasoned action approach.* Taylor & Francis.

Font-i-Furnols, M., & Guerrero, L. (2014). Consumer preference, behavior and perception about meat and meat products: An overview. *Meat Science, 98*(3), 361–371. https://doi.org/10.1016/j.meatsci.2014.06.025.

Froggatt, A., & Wellesley, L. (2019). *Meat analogues: Considerations for the EU.* Retrieved from https://www.chathamhouse.org/publication/meat-analogues-considerations-eu.

Gerber, P. J., Steinfeld, H., Henderson, B., Mottet, A., Opio, C., Dijkman, J., et al. (2013). *Tackling climate change through livestock: A global assessment of emissions and mitigation opportunities.* Food and Agriculture Organization of the United Nations (FAO).

Graça, J., Calheiros, M. M., & Oliveira, A. (2015). Attached to meat? (Un)Willingness and intentions to adopt a more plant-based diet. *Appetite, 95*(Supplement C), 113–125. https://doi.org/10.1016/j.appet.2015.06.024.

Grunert, K. G. (2006). Future trends and consumer lifestyles with regard to meat consumption. *Meat Science, 74*(1), 149–160. https://doi.org/10.1016/j.meatsci.2006.04.016.

Grunert, K. G., Bredahl, L., & Brunsø, K. (2004). Consumer perception of meat quality and implications for product development in the meat sector—a review. *Meat Science, 66*(2), 259–272. https://doi.org/10.1016/S0309-1740(03)00130-X.

Hallström, E., Röös, E., & Börjesson, P. (2014). Sustainable meat consumption: A quantitative analysis of nutritional intake, greenhouse gas emissions and land use from a Swedish perspective. *Food Policy, 47*, 81–90.

Latvala, T., Niva, M., Mäkelä, J., Pouta, E., Heikkilä, J., Kotro, J., et al. (2012). Diversifying meat consumption patterns: Consumers' self-reported past behaviour and intentions for change. *Meat Science, 92*(1), 71–77.

Lindeman, M., & Väänänen, M. (2000). Measurement of ethical food choice motives. *Appetite, 34*(1), 55–59. https://doi.org/10.1006/appe.1999.0293.

Macdiarmid, J. I., Douglas, F., & Campbell, J. (2016). Eating like there's no tomorrow: Public awareness of the environmental impact of food and reluctance to eat less meat as part of a sustainable diet. *Appetite, 96*, 487–493.

Magidson, J., & Vermunt, J. K. (2001). Latent class factor and cluster models, bi-plots, and related graphical displays. *Sociological Methodology, 31*(1), 223–264.

Malek, L., Umberger, W., & Goddard, E. (2018). Is anti-consumption driving meat consumption changes in Australia? *British Food Journal.* https://doi.org/10.1108/BFJ-03-2018-0183.

Malek, L., Umberger, W. J., & Rolfe, J. (2017). Segmentation of Australian meat consumers on the basis of attitudes regarding farm animal welfare and the environmental impact of meat production. *Animal Production Science, 58*(3), 424–434. https://doi.org/10.1071/AN17058.

McEvoy, C. T., Temple, N., & Woodside, J. V. (2012). Vegetarian diets, low-meat diets and health: A review. *Public Health Nutrition, 15*(12), 2287–2294. https://doi.org/10.1017/S1368980012000936.

Meat & Livestock Australia (2017a). Red meat industry can be carbon neutral by 2030.

Retrieved from https://www.mla.com.au/news-and-events/industry-news/red-meat-industry-can-be-carbon-neutral-by-2030/.
Meat & Livestock Australia (2017b). *State of the industry report: The Australian red meat and livestock industry*. Retrieved from https://www.mla.com.au/globalassets/mla-corporate/research-and-development/documents/industry-issues/state-of-the-industry-v-1.2-final.pdf.
Michie, S., Hyder, N., Walia, A., & West, R. (2011). Development of a taxonomy of behaviour change techniques used in individual behavioural support for smoking cessation. *Addictive Behaviors, 36*(4), 315–319. https://doi.org/10.1016/j.addbeh.2010.11.016.
National Health and Medical Research Council (2015). *Australian dietary guidelines.* Retrieved from https://www.eatforhealth.gov.au/.
Natural Resources Defense Council (2017). *NRDC: Less beef, less carbon.* Retrieved from US: https://www.nrdc.org/sites/default/files/less-beef-less-carbon-ip.pdf.
Neff, R. A., Edwards, D., Palmer, A., Ramsing, R., Righter, A., & Wolfson, J. (2018). Reducing meat consumption in the USA: A nationally representative survey of attitudes and behaviours. *Public Health Nutrition, 21*(10), 1–10. https://doi.org/10.1017/S1368980017004190.
Nestle, M., Wing, R., Birch, L., DiSogra, L., Drewnowski, A., Middleton, S., et al. (1998). Behavioral and social influences on food choice. *Nutrition Reviews, 56*(5), 50–64.
OECD (2016). Meat. *OECD-FAO agricultural outlook 2016-2025*Paris OECD Publishing. Retrieved from https://doi.org/10.1787/agr_outlook-2016-10-en.
OECD (2018). *Meat consumption (indicator) (Publication no. 10.1787/fa290fd0-en).* Retrieved 13 March 2018.
Petrie, C. (2016). Live export: A chronology. *Law and bills digest section (18 July 2016 ed.)* http://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/pubs/rp/rp1617/Chronology/LiveExport#_ftn20 Parliament of Australia.
Piazza, J., Ruby, M. B., Loughnan, S., Luong, M., Kulik, J., Watkins, H. M., et al. (2015). Rationalizing meat consumption. The 4Ns. *Appetite, 91*, 114–128.
Poore, J., & Nemecek, T. (2018). Reducing food's environmental impacts through producers and consumers. *Science, 360*(6392), 987–992.
Renner, B., Sproesser, G., Strohbach, S., & Schupp, H. T. (2012). Why we eat what we eat. The Eating Motivation Survey (TEMS). *Appetite, 59*(1), 117–128.
Romero-Ortuno, R., Walsh, C. D., Lawlor, B. A., & Kenny, R. A. (2010). A frailty instrument for primary care: Findings from the survey of health, ageing and retirement in Europe (SHARE). *BMC Geriatrics, 10*(1), 57.
Roy Morgan Research (2016). The slow but steady rise of vegetarianism in Australia. [Press release]. Retrieved from http://www.roymorgan.com/findings/vegetarianisms-slow-but-steady-rise-in-australia-201608151105.
Sheeran, P. (2002). Intention—behavior relations: A conceptual and empirical review. *European Review of Social Psychology, 12*(1), 1–36.
Shim, J.-S., Oh, K., & Kim, H. C. (2014). Dietary assessment methods in epidemiologic studies. *Epidemiology and Health, 36*. https://doi.org/10.4178/epih/e2014009 e2014009.
Shove, E. (2010). Beyond the ABC: Climate change policy and theories of social change. *Environment & Planning A, 42*(6), 1273–1285.
Sniehotta, F. F., Presseau, J., & Araújo-Soares, V. (2014). *Time to retire the theory of planned behaviour.* Taylor & Francis.
Starkstein, S., Dragovic, M., Jorge, R., Brockman, S., Merello, M., Robinson, R. G., et al. (2011). Diagnostic criteria for depression in Parkinson's disease: A study of symptom patterns using latent class analysis. *Movement Disorders, 26*(12), 2239–2245.
Steinfeld, H., Gerber, P., Wassenaar, T., Castel, V., & de Haan, C. (2006). *Livestock's long shadow: Environmental issues and options.* Food & Agriculture Org.
Steptoe, A., Pollard, T. M., & Wardle, J. (1995). Development of a measure of the motives underlying the selection of food: The food choice questionnaire. *Appetite, 25*(3), 267–284.
Tilman, D., & Clark, M. (2014). Global diets link environmental sustainability and human health. *Nature, 515*(7528), 518.
Vainio, A., Niva, M., Jallinoja, P., & Latvala, T. (2016). From beef to beans: Eating motives and the replacement of animal proteins with plant proteins among Finnish consumers. *Appetite, 106*, 92–100.
Vanhonacker, F., Van Loo, E. J., Gellynck, X., & Verbeke, W. (2013). Flemish consumer attitudes towards more sustainable food choices. *Appetite, 62*, 7–16.
Verbeke, W. (2005). Consumer acceptance of functional foods: Socio-demographic, cognitive and attitudinal determinants. *Food Quality and Preference, 16*(1), 45–57. https://doi.org/10.1016/j.foodqual.2004.01.001.
Verbeke, W., & Viaene, J. (1999). Beliefs, attitude and behaviour towards fresh meat consumption in Belgium: Empirical evidence from a consumer survey. *Food Quality and Preference, 10*(6), 437–445.
Vermunt, J. K., & Magidson, J. (2005). *A comparison between traditional and latent class. New developments in categorical data analysis for the social and behavioral sciences*.
Wansink, B. (2016). *Slim by design: Mindless eating solutions for everyday life.* Hay House, Inc.
Wellesley, L., Froggatt, A., & Happer, C. (2015). *Changing climate, changing diets: Pathways to lower meat consumption*.
Yau, Y., Thibodeau, B., & Not, C. (2018). Impact of cutting meat intake on hidden greenhouse gas emissions in an import-reliant city. *Environmental Research Letters, 13*(6), 064005.